GEOTECHNICAL ENGINEERING STUDY

Sugar Land Baseball Park
Near Hwy 6 & Hwy 90 Alt
Sugar Land, Texas

Reported to:

City of Sugar Land
Sugar Land, Texas

Prepared by:

QC Laboratories, Inc.
10810 Northwest Freeway
Houston, Texas 77092
(713) 695-1133

PROJECT NO.: 10G7296
September 2010

LABORATORIES, INC.
Engineering and Testing Services

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Engineering and Testing Services

September 7, 2010

Mr. Mike Hobbs
Director of Public Works
City of Sugar Land
111 Gillingham Lane
Sugar Land, TX 77478

Subject: Geotechnical Report for Sugar Land Baseball Park
Near Hwy 6 & Hwy 90A
Sugar Land, Texas
QCL No. 10G7296

Dear Mr. Hobbs:

We are pleased to submit our geotechnical site investigation report for the above referenced project. This study was performed at the request and authorization to proceed in general accordance with our Proposal 38566.

We appreciate the opportunity to be of service to you on this phase of the project. If we may be of additional assistance, please call.

Very Truly Yours,
QC LABORATORIES, INC.
Texas Registered Engineering Firm
F – 3601

Mario Tagavilla
Project Manager

Ray Meyer
9/7/10

STATE OF TEXAS
J. RAY MEYER
44465
LICENSED
PROFESSIONAL ENGINEER

Ray Meyer, P.E.
Director of Geotechnical Services

Attachments: Geotechnical Reports
(1 Original & 1 Copy)

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1.0 INTRODUCTION

1.1 Project Description and Scope of Services

The City of Sugar Land is planning to construct a professional minor league baseball stadium. The proposed site and the focus of this investigation for the stadium is located on the Imperial Redevelopment / Tract 3 site near the northeast corner of Hwy 6 and Hwy 90A in Sugar Land, Texas. Construction will include a three (3) level baseball stadium consisting of (from lower to higher) the field and clubhouse, concession areas and concourse level and suites/club level. In addition, berms, surface parking and utilities will also be constructed. A map of the project site with the approximate boring locations is shown on Plate No. 1.

The scope of services includes evaluating the subsurface conditions by drilling and sampling soil borings, laboratory tests of selected soil samples, engineering analysis and preparing a geotechnical engineering report for this project. The report addresses subsurface soil conditions, recommendations for foundations, pavement, utility trenching, pipe bedding and backfill considerations.

2.0 INVESTIGATION TECHNIQUES

2.1 Field Exploration

The subsurface conditions at this site were explored by drilling and sampling a total of twenty-eight (28) soil borings as follows:

Structure	Borings
Stadium	15 borings @ 30 ft
Play Field	6 borings @ 15 ft
Parking Areas	7 borings @ 10 ft

The approximate boring locations are shown on the Boring Plan in the Appendix. Boring locations were selected by Huitt-Zollars, Inc. The boring locations were located in the field by our field supervisor using a handheld GPS unit. Boring elevations were not provided. All depths in this report and on the boring logs are referenced to the ground surface existing at the time the borings were drilled.

The soil sample intervals are shown on the boring logs. The geotechnical test borings were drilled using a combination of solid stem augers above the groundwater and rotary wash techniques below the groundwater mounted on a truck-based carrier. Undisturbed cohesive samples were obtained with a 3-inch thin-walled tube sampler in general accordance with

ASTM Method D 1587. Sampling was conducted continuously from the ground surface to at least ten (10) ft and then at five (5) ft intervals after that. The shear strength of each cohesive sample was estimated using a hand penetrometer. Each sample was removed from the sampler in the field, examined and classified. Non-cohesive soils were sampled a using split spoon sampler in general accordance with ASTM Method D1586. The 2-inch diameter sampler is driven 18 inches with a 140-lb hammer falling 30 in. The number of blows to driven the sampler the last 12-in are recorded as the Standard Penetration Resistance (SPT N-value).

2.2 Laboratory Tests

In the laboratory, each sample was inspected and classified by a qualified engineer. Laboratory tests were performed on selected soil samples to evaluate the physical properties and shear strength characteristics of the foundation soils.

The geotechnical engineering properties of the strata were evaluated by the following tests:

- Visual-Classification (ASTM D2488)
- Hand Penetrometer Test/SPT
- Water Content (ASTM D2216)
- Dry Density (ASTM D2937)
- Atterberg Limits (ASTM D4318 - Method B)
- Unconfined Compression (ASTM D2166)
- Percent Passing No 200 Sieve (ASTM D 1140)
- One Dimensional Free Swell Test (ASTM D4546)

Detailed soil descriptions and results of the tests are given on the boring logs presented in the Appendix.

3.0 GENERAL SITE AND SUBSURFACE CONDITIONS

The site is relatively level and covered with tall underbrush and various size trees. Initially, the surface was dry and strong, however, following several days of rain the site became wet and difficulty was encountered moving around the site even with 4-wheel drive vehicles.

In order to access the boring locations, a dozer was required to clear paths to each site. An initial path was opened through a stand of trees along Burney Road. The location of the opening through the tree stand was provided by LJA Engineering and Surveying, Inc. The boring locations were identified in the field using a handheld GPS unit. A listing of the each boring location with the corresponding GPS reading is provided following the Boring Logs in the Appendix.

All depths in this report are referenced to the ground surface existing at the time the borings were drilled.

Based on the subsurface conditions revealed by the test borings, the subsurface conditions can be generalized as follows:

DEPTH, FEET	DESCRIPTION OF STRATUM
0 – 10 (Varies)	LEAN CLAY (CL), to FAT CLAY (CH), stiff, firm, yellowish red and reddish brown with slickensides underlain by layers of SANDY SILT (ML), LEAN CLAY WITH SILT (CL-ML), and/or SILTY SAND (SM)
10 – 30 (Varies)	SILTY SAND (SM), SANDY SILT and some CLAY WITH SILT (CL-ML), wet, loose to medium dense, gray, reddish brown.

A key to the terms and the symbols used on the boring logs are given on Plate No. 30.

The actual soil conditions varied from one boring to another and the reader is advised to review each boring for specific subsurface information.

3.1 Preliminary Ground Fault Study

The coastal plain in this region has a complex geology, several major features of which are: Gulf Coastal geosynclines, salt domes, subsidence and faulting activities. Most of the faulting activities have ceased for millions of years, but some are still active. Their movement is slow and tedious, unlike the tectonic faults that are abrupt and can be catastrophic. Ground faults can, nonetheless, be very damaging to fixed structures placed within their zone of influence.

Ground faults, if there has been recent activity, will reveal themselves with surface features such as linear breaks in pavements and linear ground surface offsets. It is not uncommon however, for this surface evidence to have been disturbed by new construction. Faults that are "active" will continue to move and reveal their presence in even recent construction, particularly in road surfaces.

The preliminary fault study was accomplished by reviewing available public information, reviewing aerial photographs and making on-site observations of the surrounding area. Based on our study of the site surface and surrounding roads no evidence of fault activity was observed in the vicinity of this project site at the time of our investigation.

4.0 WATER-LEVEL MEASUREMENTS

Groundwater was encountered in the soil borings at the time of drilling. Water level readings at the time of drilling for the respective boring are provided in the following Table. Long-term readings were not obtained because the wet rotary drilling procedure was used when water was first encountered in the boring. Fluctuations in the groundwater levels can occur due to variation in rainfall and surface water run-off. Actual depth of the groundwater should be verified prior to the beginning of construction and provisions should be made to handle water-entering excavations during construction.

Groundwater Level Readings During Drilling:

Boring No.	Total Boring Depth, feet	Groundwater Measurements, feet
B-1	30	6
B-2	30	10
B-3	15	6
B-4	30	7
B-5	30	7
B-6	10	7
B-7	30	7
B-8	30	7
B-9	30	7
B-10	30	7
B-11	10	6
B-12	30	7
B-13	10	7
B-14	10	7
B-15	10	7
B-16	30	7
B-17	15	7
B-18	15	7
B-19	15	7

B-20	15	12
B-21	30	10
B-22	10	Not encountered
B-23	30	Not encountered
B-24	30	10
B-25	30	10
B-26	30	10
B-27	10	Not encountered
B-28	15	7

Boring depths and water measurements are referenced from the ground surface existing at the time the boring was drilled.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations contained in this report are prepared based on conditions encountered in the borings drilled at this site, our field and laboratory test results of the soil samples, our past experience with Geotechnical conditions similar to those at this site and our engineering design analyses. In the event that any changes in the nature, design or location of the structure are made from those originally described to us, the conclusions and recommendations contained in this report shall not be considered valid until the changes are reviewed and the conclusions are verified in writing.

5.1 Foundation Selection

The foundation selection process must consider at least the following three topics:

1. Ability of the soil to adequately support the structures,
2. Control of foundation movement, and
3. Constructability of foundations.

The soil borings and laboratory test results reveal a site stratigraphy that consists of FAT and LEAN CLAY to about ten (10) ft below grade underlain by layers of SILTY SAND and SANDY SILT to the boring termination depths of thirty (30) ft. Ground water was measured at depths varying from six (6) ft to twelve (12) ft below existing grade.

The Atterberg Limit tests are an indirect predictor of soil activity or its potential shrink or swell with variations in the soil moisture. The Atterberg Limits indicate that the clays encountered in the upper ten (10) ft are of moderate to high Plasticity Index (PI). The clay soil has the potential to swell and shrink with changes in the moisture content. Structures supported directly on this soil will have the potential to move vertically unless special foundation measures are utilized. These special measures may include bypassing the soils with deep foundations or protecting the active soils from moisture variations.

A one-dimensional free swell test was performed on one of the soil samples from the upper clay zone. This test is a direct predictor of the shrink/swell potential of the soils at the site. The results of the test indicate the sample moved vertically by 1.28% of its initial height in a free swell condition (no confining load on the sample).

The following result was obtained from one a free swell test:

SAMPLE LOCATION	DEPTH	% PRIMARY SWELL	INITIAL MOISTURE, %	FINAL MOISTURE,%
B-5	0-2	1.28	18	34

Considering foundation performance and constructability, the soils encountered at this site are competent to support the proposed structures.

Two types of foundation systems can be considered for this site. They include shallow dug, spread footings placed in the upper clay soils or drilled piers placed in the lower sand layers.

Spread footings, sometimes referred to as dug footings, are typically no deeper than 4 ft to 6 ft below grade and are either square, rectangular, round or continuous. Spread footings may be considered for support of the lightly loaded structures like small buildings for security booths, ticket booths, equipment buildings, etc. Spread footings will be more susceptible to vertical soil movement due to the potential for the upper clay to shrink and swell. Shrink and swell can be controlled by controlling the potential for the soil moisture content to vary over time.

Larger, more critical buildings like the field and clubhouse, suites and club levels of the stadium can be supported on drilled piers foundations. Light poles and other critical vertical structures should also be supported on drilled piers.

Parameters will be provided for design of both spread footings and drilled piers.

The deepest soil boring in this study was drilled to 30 ft below existing grade; therefore, we cannot provide design parameters deeper than twenty-five (25) ft below existing grade. It is standard engineering practice to terminate deep foundation recommendations at least five (5) ft less than the deepest boring drilled.

5.2 Spread Footings Design Parameters

5.2.1 Compression Loading: Footing configuration may vary depending on its use. Footings that support individual columns may be square or rectangular (where length equals twice the width) in shape. Strip footings may be used to continuously support long walls.

Based on the soil and site characteristics, the proposed buildings may be supported on dug spread footings founded in the natural yellowish red and reddish brown lean and fat clay soil within the depth range of 4 ft to 5 ft below existing grade.

The footings should be designed for an allowable dead load bearing capacity as follows:

Footing Type	**Allowable Dead plus Sustained Live Load, ksf FS = 3**	**Allowable Total Load, ksf FS = 2**
Square or Rectangle	2.2	3.3
Strip	2.0	3.0

5.2.2 Settlement: Settlement of footings placed in the natural soil will primarily occur due to elastic deformation in the soil. If the footings are placed in fill material that may be required to construct berms or adjust the site grade, they will experience elastic settlement and may also initiate long-term settlement. The long-term settlement of footings placed in compacted fills depends on the type of material used for the fill and the degree of soil compaction. Based on our experience if the allowable pressures provided in this report are used, we anticipate short-term settlement will be less than approximately 1-inch.

5.2.3 Footing Sliding Resistance Footings may have to resist horizontal loads due to lateral earth pressures. The sliding resistance of a footing placed in the natural site clay can be estimated by applying an allowable sliding resistance friction value of 250 psf over the base of the footing. This value includes a safety factor of two (2). Eccentric loading can cause portions of footings to go into uplift while the remainder of the footing stays in compression. This friction resistance should only be applied to that portion of the footing in compression.

5.2.4 Footing Spacing Footings spaced closer together than about 2 footing widths may interact with each other. The result will may be increased settlement of the footings and a potential reduction in bearing capacity of the soil. We should consider those closely spaced footing on a case-by-case basis.

5.3 Spread Footing Foundation Installation

Installation considerations include provisions for water conditions, reinforcing and concrete placement, and monitoring. Each of these topics is discussed in the following paragraphs.

5.3.1 Spread Footing Construction

5.3.1.1 **Excavations:** The footings should be neat excavated. Excavations should be accomplished with a smooth-mouth bucket. If a toothed bucket is used, excavation with this bucket should be stopped 12 inches above final grade and the excavation completed with a smooth-mouthed bucket or by hand.

Steel should be placed and the footing concreted the same day of excavation. Sides of the excavation may slough to some extent with time. Sloughed soils and other debris in the bottom of the excavation should be removed prior to steel placement. If for some reason the footings cannot be poured the same day of excavation, a thin seal slab should be placed to protect the exposed foundation soils

5.3.1.2 **Water Conditions.** Seepage into footing excavations is not anticipated since water was not encountered in the upper 5 ft during drilling. The groundwater table may be affected by environmental factors such as infiltration from rainwater, which might affect the construction program under saturated ground conditions. If the groundwater level should rise above the base of the foundation excavation or if rain runoff should enter the excavation, the water should be removed prior to concreting. A series of sumps and sump pumps may used in the clay soils. Well points will be required in the granular materials. In any event, the ground water level should be maintained at about 2 ft below the bottom of excavations.

The presence of sand and silt layers encountered at various depths in the borings may affect the stability of footing excavations under wet or rain conditions. The contractor should be prepared to pump the water out of the excavations and the concrete should be placed in a timely manner after excavating to minimize the potential for caving of the excavation.

5.3.1.3 **Reinforcing Placement.** Reinforcing steel should be clean and free of any bond-inhibiting coating or mud. Reinforcing steel should be properly positioned and supported to assure the design cover around the reinforcing steel is achieved.

5.3.1.4 **Footing Construction Monitoring.** Depth to competent bearing soils are based on conditions encountered only at the boring locations; however, significant variations can occur over short horizontal distances. Prior to placement of concrete, the footings should be observed by a representative of the QC Laboratories, Inc. geotechnical engineer to determine that:

5.3.1.4.1 The footing bears in the proper bearing strata at the depth recommended in this report.
5.3.1.4.2 The footing is constructed to the proper dimensions and steel reinforcements are placed as shown on the structural drawings.
5.3.1.4.3 Excessive cutting, build up of cuttings, and any other soft compressible materials have been removed from the bottom of the excavations.

A QC Laboratories, Inc. representative should be present during foundation installation to verify that the proper bearing stratum has been reached, the foundation dimensions are as designed, and that the excavation is clean and dry before reinforcing and concrete placement.

5.4 Design Recommendations for Drilled Piers

Axial Capacity: The proposed three-story structure and light pole structures can be supported on a foundation system of drilled piers. At this time, the foundation loads are not available to us. We have provided a Table that includes the allowable soil-pier friction and end bearing pressures. The foundation designer can use these values to design the diameter and length of the foundation piers based on the design loads. Soil borings for the three-story building terminated at 30 ft below existing grade. Piers should not be designed to extend deeper than the deepest soil boring less 5 ft. In this case, we cannot provide soil design data beyond twenty-five (25) ft below existing grade.

The following parameters may used to estimate drilled pier capacity:

Allowable Soil-Pier Friction and End Bearing

Depth below Exisitng Grade, ft	Allowable Side Friction Compression, ksf SF = 2	Allowable Side Friction Tension, ksf SF = 2	Allowable End Bearing, ksf SF = 3
0 – 5	Neglect	Neglect	Neglect
5 – 10	0.13	0.1	0.30
10 – 20	0.60	0.42	0.80
20 – 25	0.70	0.49	0.85

Settlement of pier-supported footings at this site will primarily occur due to elastic deformation in the soil. We anticipate a settlement of about one (1) inch. A detailed settlement analysis was beyond the scope of this study. However, we will be pleased to provide necessary recommendations on anticipated settlement based on laboratory consolidation tests and settlement analysis.

The minimum center-to-center spacing between adjacent piers should be 3 times the shaft diameter to minimize the effect of load overlapping in the pier bearing area. If however, there are closely spaced piers in the layout then a reduction factor applied to the allowable bearing capacity based on the pier spacing and soil conditions should be utilized. We recommend that the designer contact QC Laboratories to determine the reduction factor if required at this project.

5.5 Pier Foundation Installation

Installation of drilled piers can be accomplished in general accordance with the *Drilled Shafts: Construction Procedures and Design Methods* by FHWA, 1999. If drilled piers are considered, additional guidance can be provided for installation. The tips of drilled piers at this site will terminate into sand and silt from about 10 ft to 25 ft below existing grade. Care must be exercised during installation so as not to disturb the soil at and below the tip area of the pier. With the use of drilling fluids, the fluids are displaced with proper pier concreting activities which include the use of tremie pipes and maintaining a head of concrete in the tremie to counteract the water pressure.

5.6 Ground Water Considerations for Drilled Piers

Drilled pier installation below the ground water level will require additional consideration. Drilling into sand below the ground water level will require a careful understanding of the drilling technique and soil/water behavior. The drilling operation will require the use of drilling fluids and maintaining a positive head of concrete throughout the entire installation procedure.

5.7 Pier Construction Monitoring

The installation of the auger cast piers should be observed on a full-time basis by a representative of QC Laboratories. The field representative will monitor the grout volume for piers and pier embedment depth. A site-specific program will be developed prior to construction and after the foundation system is selected.

5.8 Pier Load Tests

Full-scale pier load tests should be performed to verify the capacities provided in this report or to modify the embedment length. A load test will provide valuable design and construction information prior to production pier installation. Load tests will help to reduce unforeseen conditions for the contractor. QC Laboratories should be retained to provide guidance to the selection of the test procedure and to observe and monitor the test performed and to interpret the load test results.

5.9 Illumination Structure Foundations

Light poles may used to illuminate the playing field as well as parking and driveway areas. These structures will be subjected to axial loads and lateral loads. Soil friction values are provided in the foregoing section for both compressive and uplift load resistance. Laterally loaded structures should be addressed using specially design software to predict structural responses to the combined effects of axial and horizontal loading. At this time, since load conditions are not known, lateral response curves predicting induced deflection, moment and shear cannot be developed. When loads and foundation sizes are known, QC Laboratories, Inc. can perform the recommended lateral analyses.

5.10 Considerations for Floor Slabs

The following options may be considered for the floor slab of the proposed structures at this site.

Structural Slab: Structural isolation is the design approach that most significantly reduces the risk of movement due to the active subgrade soils. Structural isolation involves structural support of the entire floor slab and any grade beams on a drilled pier or spread footing foundation system. The floor slab is either cast on void forms or constructed of precast elements with a topping slab. A 6-in. void is maintained between the floor slab and the underlying soils.

Slab on Compacted Select Fill: As previously discussed, the clays at this site would be described as having a moderate to high shrink/swell potential. Heaving may cause some distress to the lightly loaded floor slabs and thus it is recommended that some measures be taken to reduce the potential movements. A measure commonly employed in the Houston area consists of the placement of a blanket of inactive fill beneath the floor slab and developing proper site drainage.

Placement of pavement adjacent to the structures is recommended because it will provide a barrier for movement of surface water beneath the building. Free water from rain, sprinkler system or leaking water faucet can contribute to moisture accumulation in the subgrade soils if positive drainage is not adequate at the project site. It should be noted that leaking utilities such as broken water lines or sewers can also be a direct source of free water to cause soil swelling. Because of the potential for variation of moisture content in the subsurface soil there is a certain level of risk involved in this type of foundation.

If the slab-on-fill approach is selected, the concrete slab shall be placed on a minimum of twenty-four (24) inches of non-active type select fill. Construction on expansive soils, such as are typical of this site, involves some inherent risks. If the above described fill recommendations are followed, it is our opinion that the risk of significant distress to the floor slab resulting from expansive clays will be low to moderate. However, it should be noted that some movements might occur due to long term moisture changes in the subsoil.

The building pad area should be prepared as follows:

(1) The site should be stripped of topsoil and miscellaneous fill materials. The subgrade should be proof rolled to evidence any soft spots that should be excavated to firm soil.

(2) The subgrade should be scarified to a depth of 6 inches and moisture conditioned to above optimum. The soil should be compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor Density Test (ASTM D698).

(3) Select fill used to elevate the grade should be composed of clean sandy clay with a liquid limit less than 40 and a plasticity index (PI) between 7 and 20.

(4) The fill should be placed in 8-inch loose lifts and compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor Density Test (ASTM D698). The moisture content should be within ±3% of optimum.

A vapor barrier should be selected by the structural engineer that will be protective of the intended floor covering. The vapor barrier should be installed as instructed by the flooring manufacturer. The excavations for the grade beams should be clean and free of any loose materials prior to the concrete placement.

The following features should be incorporated into the design and construction of building slabs at the site:

1. Trees and large shrubs should be planted away from the slab. Use native plants that do not require significant irrigation,
2. The utility trench surrounding the utility pipes should be plugged with a bentonite grout for a distance of at least 2-ft on either side of their exit from below the building slab. This will reduce the chance for water to use the utility trench as a conduit,
3. Rainwater should be carried to storm sewers by down spouts and gutters,
4. The soil surface adjacent to the slab should be sloped away from the slab to discourage water ponding,

5. Irrigation system piping should be located at least 5-ft away from the building slab.

5.11 Permanent Lateral Earth Pressure

Lateral earth pressure will be exerted on the exterior walls of below-grade structures and where compacted backfill will be placed behind vertical walls. There are three "states" of lateral earth pressure; active state, passive state and at rest state. The lateral earth pressure state will be significantly dependent on the allowable movement of the wall. Permanent lateral earth pressure will be provided in this report as a triangular load increasing in magnitude with an increase in depth.

Active pressure will occur if the wall is unrestrained at the top and is allowed to move away from the earth as pressure is applied. Active pressure will typically exert the lowest of the earth pressure values. At the opposite end of the earth pressure spectrum is passive earth pressure that occurs when a wall or footing moves into the soil. Passive earth pressure is typically the largest of the earth pressure states values. Between these two earth pressure states is the at-rest earth pressure. The at-rest earth pressure is developed when the wall allows for limited relative movement and for long-term situations of below grade walls, truck dock walls and other structures. Design parameters for the at-rest state are provided in the Appendix.

In addition to the lateral earth pressure developed from the soil, other lateral pressures should be considered. They include surcharge loading and water pressure.

Surcharge pressures are the result of applied vertical loads above the top of the wall or along the vertical face of the wall. The lateral surcharge pressure is estimated by multiplying an earth pressure coefficient by the applied vertical force or pressure of the surcharge.

Water may build up behind the walls of below grade structures. This will add lateral pressure that the wall will have to resist. Water behind walls can have a number of sources including but not limited to groundwater, rainwater runoff during a rain event, irrigation water and leaking utility pipes.

At this site, the ground water varies from 6 ft to 10 ft below grade. However, the below grade walls must be designed to accommodate the potential for other water sources previously mentioned.

As an alternative, a drain system can be installed behind the walls to remove the water and reduce the hydrostatic pressure. The drain system should be installed behind the walls and should be connected to a drainpipe that will carry the water to a location away from the site. The drain system MUST have a valve that will prevent water from flowing back into the drain system and loading the wall.

Wall pressure diagrams are provided in the Appendix. The diagram provides design data for the following conditions:

Figure 1 Cantilever Wall **with or without** Water

5.12 Below Grade Wall Construction Considerations

Wall Excavations

It is assumed the open cut technique will be used. All excavations at the site should be performed in accordance with the latest provisions of OSHA. For open cut construction in the clay above the water table and for excavations less than 5 ft deep, a slope of 2:1 (V:H) may be attempted. A flatter slope may be required to maintain a stable slope. It is recommended that the slopes be protected from the elements by draping the slopes with impermeable plastic sheeting. This will help maintain consistent soil moisture content and will help to shed rainfall.

Backfill Placement Behind Walls: During the backfilling operation, soil compaction within 3 ft of the back of the wall should not utilize heavy motorized compaction equipment. Heavy equipment used within 3 ft of the wall will cause lateral earth pressures to be greater that given in this report and are in addition to the pressures provided in this report. The soil within 3 ft of the wall should be hand-compacted with small portable motorized equipment that provides a tamping action. The maximum compacted density of the backfill within 3 ft of the wall should be about 90% to 93% of Standard Proctor Density (ASTM D 698). The backfill material beyond this 3-ft zone should be compacted to at least 95% Standard Density. Significant structural damage and lateral movement of the wall will occur if a full sized compactor is used within 3 ft of the wall.

5.13 Pavement Recommendations

The near surface soils are medium to high plasticity clay soils that will require addition of stabilizing agents to allow for sufficient pavement performance. Due to the surface soil encountered at the site there is also a potential for pumping during compaction activities. We recommend chemical stabilization utilizing hydrated lime be used. For estimate purposes use 6 percent lime by dry weight of the subgrade soils. The exact percentages can be specified after sampling the rough graded site and running the stabilization test in the laboratory.

No traffic information is available for design of pavements. The assumptions utilized in our pavement thickness analysis are summarized on Plate No. 31. If the actual traffic conditions are different from that is assumed, the client should contact QC Laboratories so that we can revise and provide appropriate recommendations. The following pavement thicknesses are based on these assumptions and procedures published by the Portland Cement Association and the National Crushed Stone Association.

Recommendations for material properties for the paving layers are provided on Plate No. 32. It is estimated that the service life for a properly constructed and maintained pavement will be in order of 20 years. Proper civil design features such as joint design; quantity shoulder support should be incorporated into the plans and specifications. Joints for concrete pavements may be designed using the Texas Department of Transportation Item 360 (Latest Revision). Periodic maintenance will be required.

The following paving thicknesses may be used for the site paving:

Parking Lots - Automobile Only

Flexible Base	Rigid Pavement
1.5” Hot Mix Asphaltic Concrete 7.0” Crushed Limestone 8.0” Stabilized & Compacted Subgrade	5.0” Reinforced Concrete 8.0” Stabilized & Compacted Subgrade

Medium Duty Access Drives

Flexible Base	Rigid Pavement
2.0“ Hot Mix Asphaltic Concrete 7.0” Crushed Limestone 8.0” Compacted Stabilized Subgrade.	6.0” Reinforced Concrete 8.0” Compacted Stabilized Subgrade.

Heavy Duty Access Drives

Flexible Base	Rigid Pavement
2.5" Hot Mix Asphaltic Concrete 10.0" Crushed Limestone 8.0" Compacted Stabilized Subgrade.	7.0" Reinforced Concrete 8.0" Compacted Stabilized Subgrade.

5.14 Underground Storm and Sanitary Sewer Utility Lines

Subsurface Conditions and OSHA Soil Type: The subsurface soil conditions as determined from the drilling and testing of the Geotechnical borings show that the natural soil is comprised of LEAN CLAY (CL) and FAT CLAY (CH) to about 10 ft below exisitng grade. As discussed earlier in the report, the depth of upper clay soil can vary. This upper layer is underlain by SILTY SAND (SM) and SANDY SILT (ML) generally below the water table. Based on their tested engineering properties, soils at this site can be classified in accordance with OSHA Regulations 1926 Subpart P as Type "C". While the upper soils are cohesive, there is a strong likelihood that the secondary structure of fissures and sand seams will present stability issues for open cut construction. The lower material is sand and silt below the water table and should also be classified as Type "C".

Excavation Stability Considerations

Excavations for utility lines may be performed by open cut excavation method. All open cut excavations should be performed in accordance with the latest OSHA rules and regulations. As previously discussed, the laboratory tests indicate that the classification of materials encountered at this site can be classified as Soil Type "C".

Flat side slope gradients and shoring should be maintained if site conditions call for or have traffic or other machinery loads during construction. If any sloughing, subsidence or tension cracks are observed in the soil during construction, the contractor should immediately evacuate the trench and notify the site "competent person" for guidance.

The contractor's designated "competent person" should review the stability considerations in this report to determine the appropriate approach to trench safety at the site. A registered professional engineer licensed by the State of Texas should design all trench shoring systems.

5.15 Temporary Lateral Earth Pressures Support Systems

Lateral earth pressures will be developed that must be resisted by structural shoring if vertical cuts are opened during construction. The magnitude and distribution of the lateral earth pressure will depend on the type of shoring that is selected. Cantilever shoring where there is no internal or external bracing will typically have a triangular pressure distribution with the earth pressure increasing with increasing depth.

Braced shoring where there is either internal bracing such as raked or horizontal bracing, will exhibit a somewhat uniform pressure between the bracing levels. Therefore, it would not be advisable to apply a single pressure diagram and lateral pressure values to these differing systems.

The following soil parameters are provided to assist the retention system designer complete an acceptable design for the retention system:

Depth, ft	Soil Type	Soil Total Unit Weight, pcf	Soil Submerged Unit Weight, pcf	Water Weight, pcf	Soil Earth Pressure Coefficient
0 – 7	LEAN and FAT CLAY	140	80	60	1.0
7 – 30	SANDY LEAN CLAY, CLAYEY SAND, SILTY SAND	120	60	60	1.0

The LEAN and FAT CLAY is firm to stiff and contains secondary structures of fissures, vertical and horizontal sand and silt seams and partings. These secondary soil structures will become planes of weakness and form preferential planes of failure when a vertical cut, such as the pipeline excavation, is created in the soil formation. In the absence of firm lateral support, the fissures will open allowing runoff water to enter. This will increase the lateral pressure and may initiate soil failure along these fissures.

If a vertical wall failure were to occur in the soil, the result is that the full weight of the soil will be imposed on the lateral earth support system. Therefore, when considering worker safety relative to vertical earth cuts, we recommend a lateral earth pressure coefficient of one (1).

Storm and Sanitary Sewer Line Bedding and Backfill Sewer line bedding and backfill should be designed in accordance with the City of Sugar Land's ***Design Standards*** document dated June 2007 and Revised in August 2008. An associated document is the City of Sugar Land's ***Standard Details*** and should be consulted.

Bedding Criteria: Generally, sewer line bedding will be cement stabilized sand or approved granular material. The cement-stabilized sand must meet the criteria in Section 3.2 of the ***Design Standards*** Document. The cement-stabilized sand (CSS) must consist of at least one and one-half (1-1/2) sack of cement per yard of sand. The CSS should achieve a minimum unconfined compression strength of at least 100 psi at 48 hrs when compacted to at lest 95% standard density.

Bedding and backfill differs based first on the sewer line location relative to the roadway. The next criterion depends on the condition of the bedding soil observed at the time of excavation. The bedding criterion is different if the bedding soil is in a wet condition such as at or near the groundwater level. If groundwater is encountered, the requirements of the ***Standard Details*** Sheets SL-18 (Sanitary Sewer) and SL-19 (Storm Sewer) should be used. Encountering ground water at the bedding level will require well pointing the excavation so that the groundwater is maintained one (1) ft below the bottom of the trench for a minimum of 24-hrs after bedding and backfill is placed.

Trench Backfill Criteria

The City of Sugar Land provides guidance for trench backfill based on the location of the pipe relative to paving. Generally, if the pipe is not below paving, then the backfill is compacted to at least 95% standard proctor. If the pipe is below paving, then the backfill may be a combination of CSS below lime stabilized subgrade for the paving support, both materials requiring compaction to at lest 95% standard density.

The designer should refer to Sugar Land's Standard Details sheets SL-18 and SL-19 for specific details and requirements of pipe bedding and backfill.

5.16 Playing Field Grade

The playing field will be improved to allow drainage after rains and irrigation. We assume that the playing surface will consist of layers of soil support, drainage and vegetation surface. We are not aware of the final site grade vs. the exisitng grade, but elevation adjustments may be required. The current site surface should be striped of surface vegetation and loose soil. The site should be proofrolled and then recompacted to at least 95% of Standard Proctor (ASTM D 698). Backfill required to adjust the grade can either consist of select fill as described in the paragraph below of by using other material as may be recommended by the playing field consultants.

5.17 Structural Fill Selection and Placement and Subgrade Preparation

In general, site preparation should consist of removing grass, tree roots, and stripping organic topsoils. Also, miscellaneous fill materials like glass pieces, pea gravel, construction debris and other organic matter, if present, should be over excavated and removed prior to proof rolling of the site. The exposed subgrade should be proof-rolled to detect local weak areas that should be excavated, processed, and recompacted in loose lifts of approximately eight-inch thick.

Select, structural fill when utilized should consist of sandy clay with liquid limit less than 40 and plasticity index (PI) between 7 and 20. This fill should be placed in loose lifts of approximately eight-inches in thickness and compacted to a minimum of 95% standard proctor density (ASTM D 698) at moisture content within ±3% of optimum.

Trees located within or for a distance of 10-feet outside the building pad limits, should be removed. Tree stumps including the root bulb with roots of size half inch diameter and larger should be grubbed and removed. Grubb holes in floor slab and pavement areas should be backfilled using select fill soils in layers of approximately eight-inches in thickness and compacted to a minimum of 95% standard proctor density (ASTM D698) at moisture content within ±3% of optimum

Select Fill Material Monitoring:

Select fill material should have a Plasticity Index (PI) ranging from 7 to 20. Atterberg Limits tests are performed on potential borrow sources in order to verify that a material can satisfy the project PI requirements. Due to the nature in which natural soils are formed and deposited, there can be significant variation in the PI values for a single borrow pit. The only way to check for consistency of the select fill material's PI value is to perform periodic PI tests of the material being delivered to the site.

We strongly recommend that samples of the select fill being delivered to this site be tested on a periodic basis. The reasons to test samples include:

1. when the material changes colors,
2. when the material changes texture (i.e., it feels less sandy, more silty , etc.)
3. when the borrow source location changes within the same pit or to a completely different location.
4.

5.18 Construction Site Preparation

The site will have to be cleared of vegetation and trees as an initial step to site preparation. This operation will result in ground surface disturbance. If a rain event occurs after site clearing, the surface will become wet and weak. Ponding water will also soften the site surface and can result in very difficult site accessibility conditions following periods of rain. The site surface should be prepared in such a manner that rain water does not pond during construction. A series of swales cut into the site will help channel rainwater to collection points away from the site. Run off water should be directed in such a manner that it does not return to the site of adversely affect another area of the site

Groundwater is relatively shallow at this site. The groundwater depth will have an effect on the constructability of below grade structures. It is our recommendation that the groundwater level should be maintained at about 2 ft below the bottom of excavations for foundations, utilities and other below grade structures. .

5.19 Wet Weather Construction Considerations

During wet weather conditions the surface soils may become saturated. This can result in difficult ground conditions for construction traffic and pumping action during compaction thus affecting the overall construction schedule and associated costs. Such type of ground conditions may require special approaches to mitigate the soil conditions and aid rapid construction. They include using drying agents such as fly ash and or using appropriate chemical stabilization methods.

If such conditions are encountered, QC Laboratories, Inc. should be contacted to evaluate the actual site conditions and provide necessary recommendations.

5.20 Site Drainage

It is recommended that site drainage be well developed. Surface water should be directed away from the foundation soils by using a minimum slope of 5% within 10 feet of foundation. No ponding of surface water should be allowed near the structure.

5.21 Vegetation Control

We recommend trees not to be planted closer than half the canopy diameter of mature trees from the grade beams, typically a minimum of 20 feet. This will minimize possible foundation settlement caused by the infiltration of moisture around tree root systems. Geotechnical engineer should be contacted for further recommendations if any existing trees within a distance of 25 feet of the structure are planned for removal.

6.0 BASIS FOR RECOMMENDATIONS

The recommendations provided are based in part on project information provided to us and they only apply to the specific project and site discussed in this report. If the project information in this report contains incorrect information or if additional information is available, you should convey the correct and or additional information to us and retain us to review our recommendations. We can then modify our recommendation if they are inappropriate for the proposed project.

Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings will be different from those at specific boring locations and that conditions will not be as anticipated by the designers or contractors. In addition, the construction process may itself alter soil conditions. Therefore, experienced QC geotechnical personnel should observe and document the construction procedures used and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with the timely recommendations to solve the problems created.

The owner should retain QC Laboratories, Inc. to review the final design documents and plans to verify that the recommendation contained in this report have been interpreted as intended based upon our familiarity with the project and the subsurface conditions.

We will be happy to discuss our recommendations with you and are prepared to provide any additional studies or services recommended to complete this project. We look forward to serving as your geotechnical engineer and construction materials consultant on the remainder of this project and future projects.

7.0 OBSERVATION DURING CONSTRUCTION

The recommendations are based on the subsoil data in the field exploration and laboratory testing. Due to the geological deposition of the Pleistocene soils in the Gulf Coastal area, variances may occur between boring locations. Therefore, the footing excavations should be observed under the supervision of a QC Laboratories geotechnical engineer to confirm that the bearing soils are similar to those encountered in our field exploration and that the footing areas have been properly prepared.

The QC Laboratories geotechnical engineer should be immediately notified should any subsoil conditions be uncovered that will alter the conclusions and recommendations contained in this report. Further investigation and supplemental recommendations may be required if such a condition is encountered.

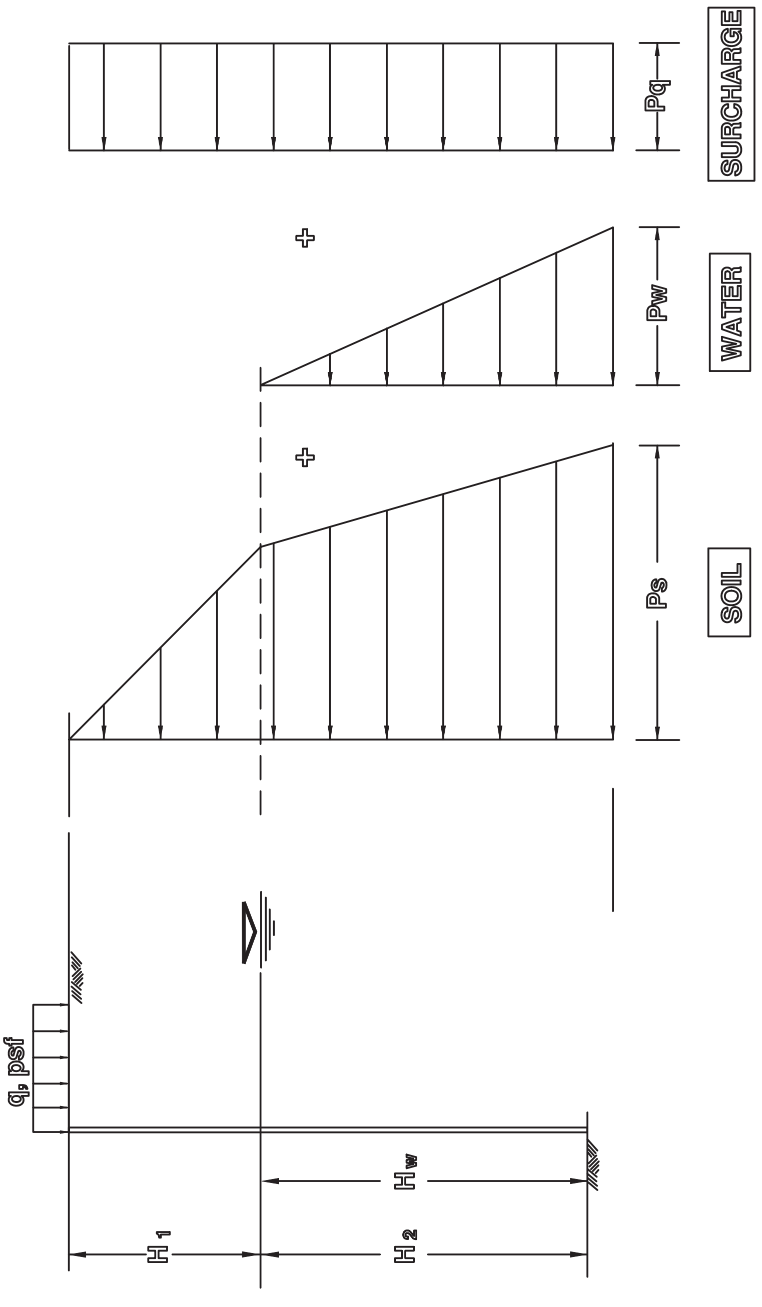
Samples of the subgrade soil and structural fill material should be obtained prior to the compaction operations for laboratory moisture/density testing (Proctor tests). The tests will then provide a basis for evaluating the in-place density requirements during compaction operations. A qualified soil technician should perform sufficient in-place density tests during the filling operations to verify that proper levels of compaction are being attained.

Construction Materials Testing:

The recommendations in this geotechnical report were based on the assumption that QC Laboratories would be employed to monitor the installation of the foundation and to provide Construction Material Testing (CMT) during the foundation and pavement construction. CMT services are required to make observations and testing during the foundation, floor slab and pavement installation. It may be occasionally required that QC Laboratories provide addendums to the original geotechnical recommendations based on the CMT observations or CMT test results which uncover site conditions that were not known when the geotechnical report as originally issued. New or changed site information, which is not properly communicated to the Geotechnical Engineer of Record may result in a foundation that does not perform as originally intended.

8.0 APPENDIX

The following illustrations are attached and complete this report:



Hw = Depth to water

H1 = Height of non-submerged soil

H2 = Height of submerged soil

q = Applied surcharge

Ps = (80 pcf x H1) + (45pcf x H2)

Pw = 60 pcf x Hw

Pq = 0.5 x q

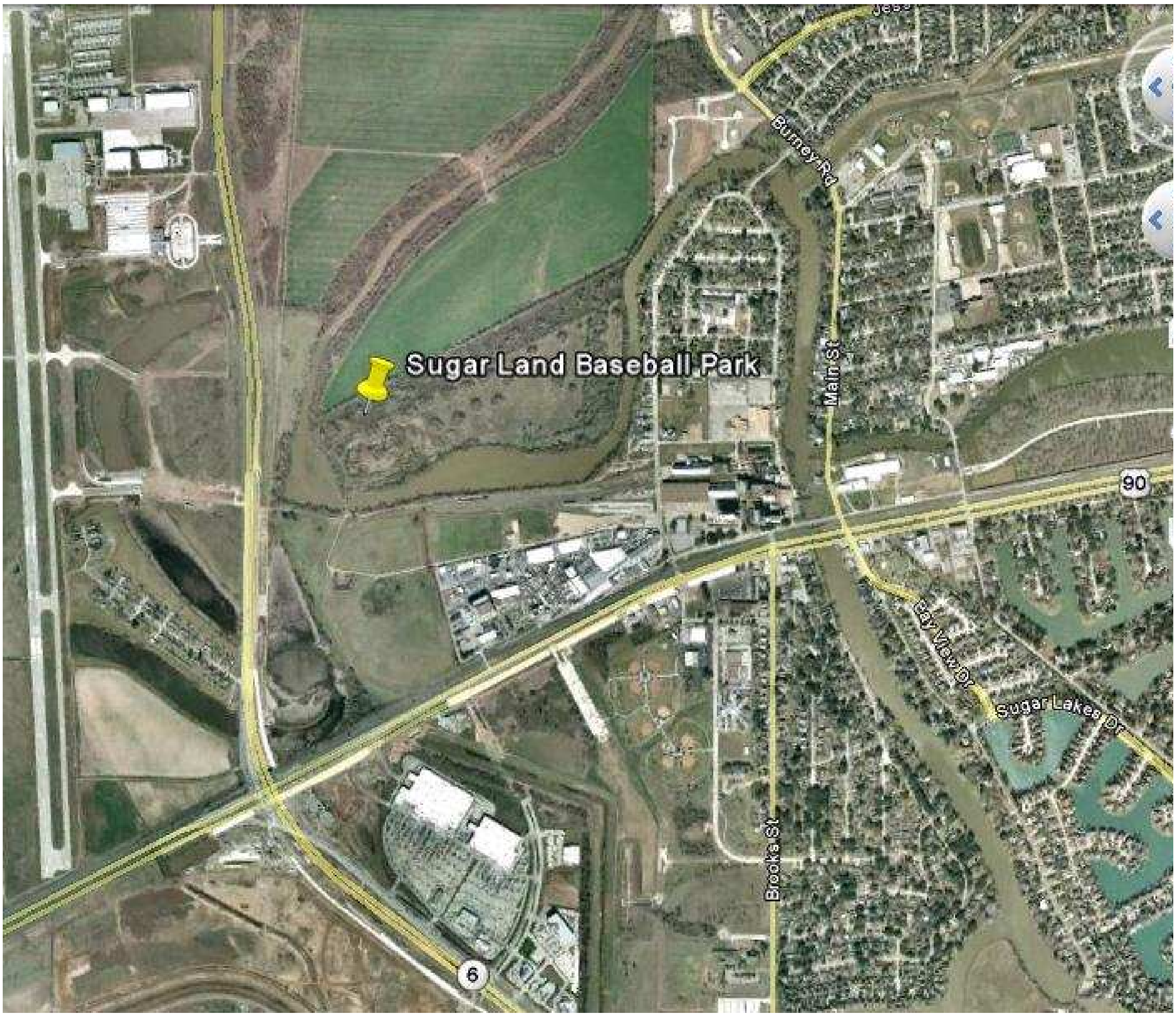
LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

WATER BEHIND WALL

PROJECT NO.: 10G7296

QC LABORATORIES, INC.

FIGURE 1

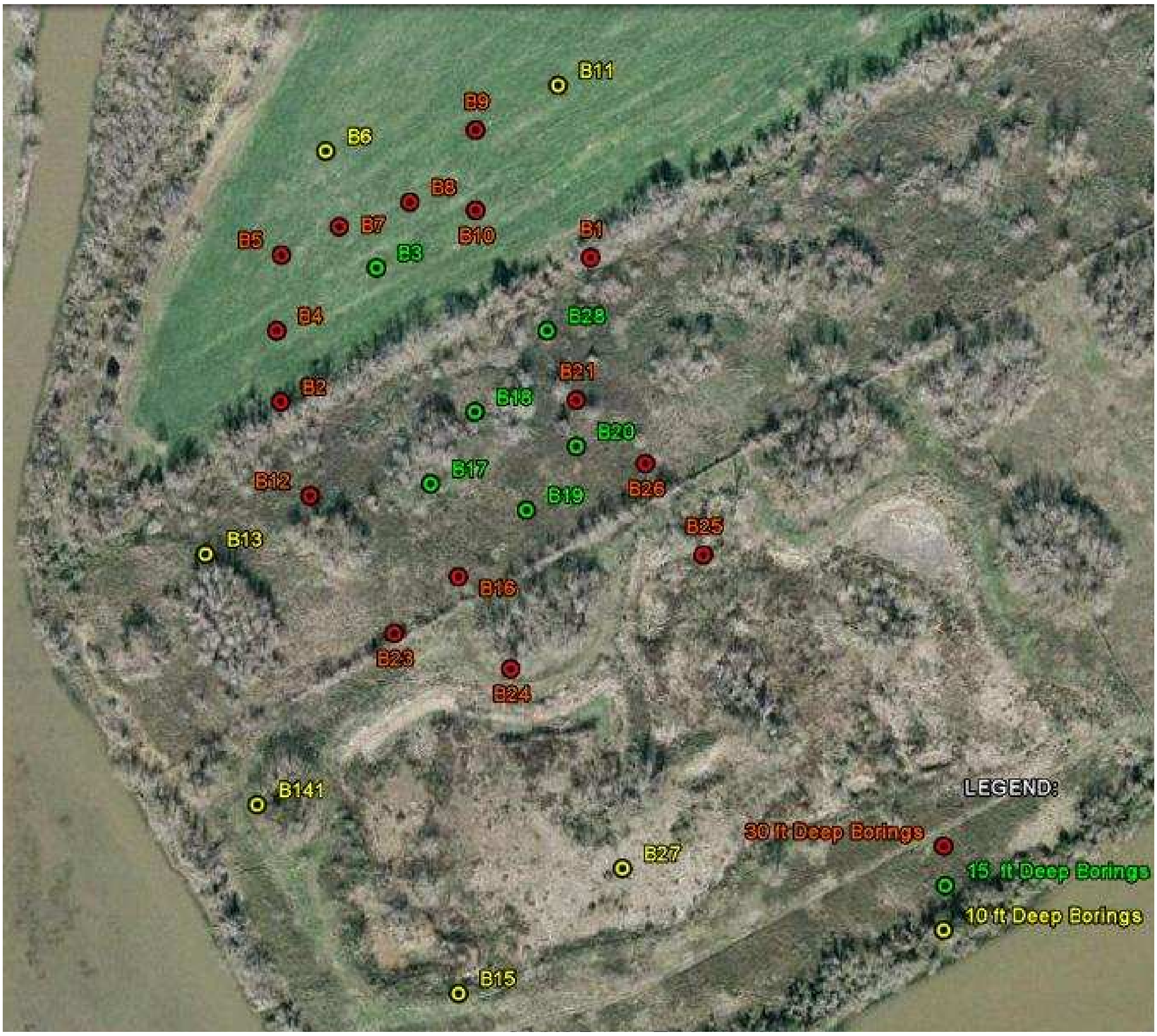


VICINITY MAP

PROJECT: **Sugar Land Baseball Park** **Project No.: 10G7296**
LOCATION: **Near Hwy 6 & Hwy 90A**
Sugar Land, Texas

QC LABORATORIES, INC
Geotechnical & Materials Engineers

Plate No. 1A



PLAN OF BORINGS

PROJECT: **Sugar Land Baseball Park**
LOCATION: **Near Hwy 6 & Hwy 90A**
Sugar Land, Texas

Project No.: 10G7296

APPROXIMATE BORING LOCATION
NOT TO SCALE

QC LABORATORIES, INC
Geotechnical & Materials Engineers

Plate No. 1B

LOG OF BORING NO. **B-1**

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-16-10 COMPLETION DEPTH : 30.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
		SURFACE ELEVATION:							
	0	LEAN CLAY (CL), stiff, yellowish red and reddish brown with slickensided	100	24	41	18	23		
		FAT CLAY (CH), stiff, yellowish red and reddish brown	99	25					
	5		95	23	56	18	38		
		LEAN CLAY WITH SILT (CL) & (ML), wet, reddish brown with loose silt layers		37	37	18	19	96	4
				28					3
	10	SILTY SAND (SM), loose, reddish brown		31				38	18
				29					21
	15	SANDY SILT (ML), loose, reddish brown		25				63	23
				25					22
	20	SILTY SAND (SM), loose to medium dense, reddish brown							
	25			26					26
				24				16	26
	30	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (scale 0.5, 1.0, 1.5, 2.0, 2.5)

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 6.0 FT. DURING DRILLING.

Plate No. 2

LOG OF BORING NO. **B-2**

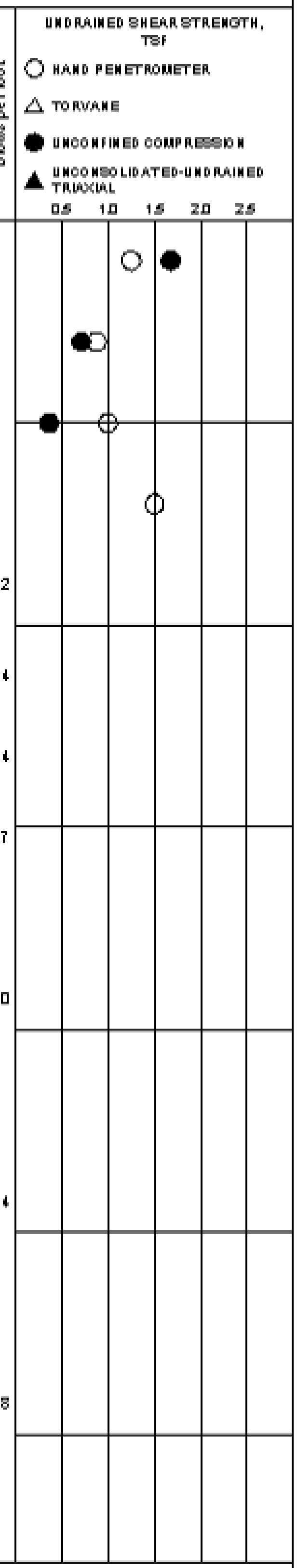
QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-23-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
	0	LEAN CLAY (CL), stiff to soft, yellowish red and reddish brown	105	18	35	17	18		
		-with slickensided between 2' to 4'	99	26					
	5		95	24	33	19	14		
		SILTY SAND (SM), loose, reddish brown		22				24	
				23					2
	10	-becomes wet between 8' to 10'		22					4
				25				16	4
	15			24					7
		SILT (ML), loose, reddish brown		31				92	10
	20	SILTY SAND (SM), loose to medium dense, reddish brown							
	25			26					14
				25				31	18
	30	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF



WATER OBSERVATIONS:

∇ : FREE WATER ENCOUNTERED AT 10.0 FT. DURING DRILLING.

Plate No. 3

LOG OF BORING 7296.GPJ QC_LABS.GDT 9/3/10

LOG OF BORING NO. B-3

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

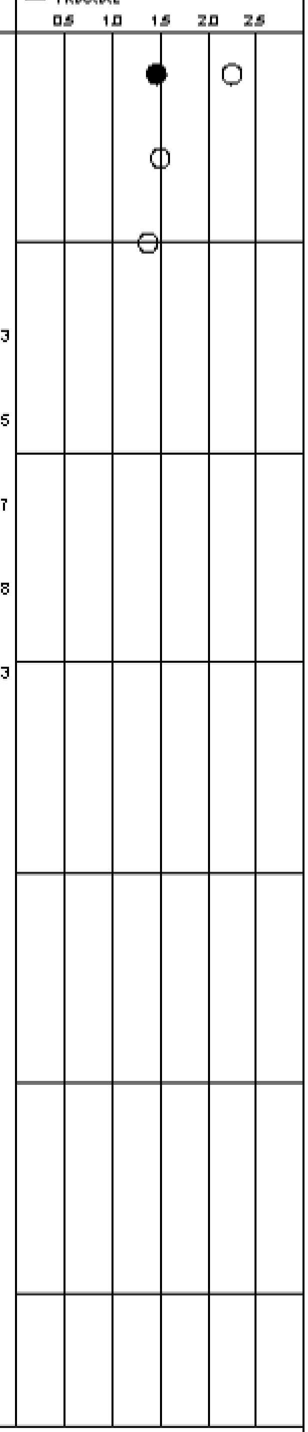
PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 16.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0–2	LEAN CLAY (CL) , stiff and very stiff, reddish brown with slickensided	120	12					
2–6	-becomes brownish yellow with sand pockets between 2' to 6'	102	18	26	18	8		
	-with loose silt layers between 5' to 6'		26					
6–12	SILTY CLAY (CL-ML) , wet, yellowish red and brown with loose silt layers		28	23	19	4		3
			27					5
			29					7
12–16	SANDY SILT (ML) , medium dense, yellowish red		26					8
			26					13
	Boring terminated at 16 feet							

UNDRAINED SHEAR STRENGTH, TSF

○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL



WATER OBSERVATIONS:
▽ : FREE WATER ENCOUNTERED AT 6.0 FT. DURING DRILLING.

Plate No. 4

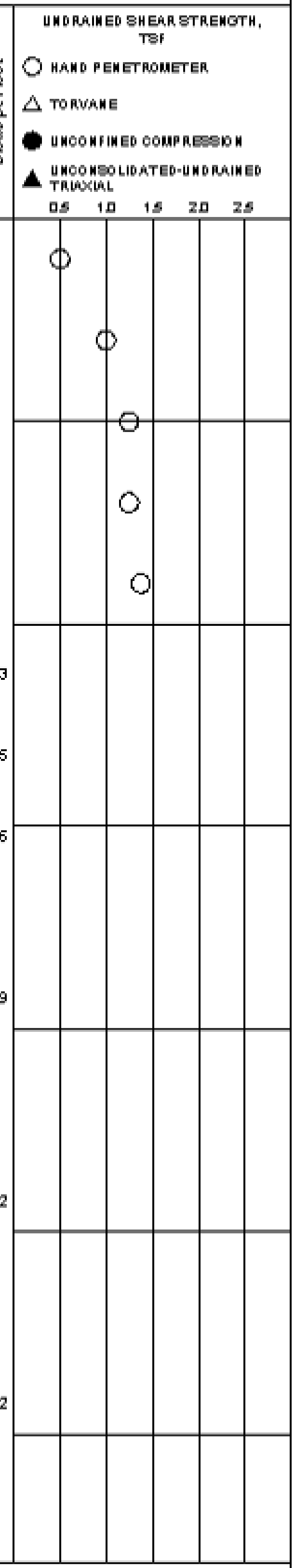
LOG OF BORING NO. B-4

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-23-10 COMPLETION DEPTH : 10.0 FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION:								
	0		LEAN CLAY (CL), firm, reddish brown and yellowish red		97	20					
						26	29	12	17	98	
	5		SILTY CLAY (CL-ML), firm to stiff, yellowish red and brown			34					
			-with loose silt layers between 7' to 8'			29	24	21	3	87	
			SANDY SILT (ML), wet, medium dense, yellowish red and brown			25					
	10					23					13
			SILTY SAND (SM), loose to medium dense, reddish brown			25				26	5
	15					24					16
	20					22					19
			POORLY GRADED SAND WITH SILT (SP-SM), medium dense, reddish brown			20				8	22
	25										
	30					18					22
			Boring terminated at 30 feet								

UNDRAINED SHEAR STRENGTH, TSF



WATER OBSERVATIONS:
∇ : FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 5

LOG OF BORING 7296.GPJ QC_LABS.GDT 9/3/10

LOG OF BORING NO. B-5

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 30.0 FT.

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (scale 0.5, 1.0, 1.5, 2.0, 2.5)

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot	UNDRAINED SHEAR STRENGTH, TSF
0	LEAN CLAY (CL), firm, reddish brown and yellowish red with slickensided	103	18	30	19	11			● ~1.0; ○ ~2.25
	SILTY CLAY (CL-ML), yellowish red and brown		19					4	
5	SANDY SILT (ML), loose, yellowish red		25				72	4	
	-with loose silt layer between 6' to 8'		26					8	
	SILTY SAND (SM), medium dense, reddish brown		26				45	13	
30	Boring terminated at 30 feet								

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 6

LOG OF BORING NO. B-6

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 10.0 FT.

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (scale 0.5, 1.0, 1.5, 2.0, 2.5)

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot	UNDRAINED SHEAR STRENGTH, TSF
			SURFACE ELEVATION:									
	0		LEAN CLAY (CL), stiff, reddish brown and yellowish red with slickensided		99	18	49	21	28			● ~1.0, ○ ~1.4
			SANDY SILTY CLAY (CL-ML), yellowish red and brown			18					13	
	5					24				60	15	
			SANDY SILT (ML), loose, yellowish red and reddish brown			25					4	
						20				59	5	
	10		Boring terminated at 10 feet									

WATER OBSERVATIONS:

∇: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 7

LOG OF BORING 7296.GPJ QC_LABS.GDT 9/3/10

LOG OF BORING NO. B-7

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
LEAN CLAY (CL), very stiff to stiff, reddish brown and yellowish red with slickensided		19	44	24	20		
	102	20					
SILTY CLAY (CL-ML), yellowish red and brown		24					
		27				60	3
SANDY SILT (ML), loose, yellowish red and brown		21					7
-becomes medium dense between 10' to 12'		21					20
SILTY SAND (SM), medium dense, reddish brown		18				25	20
		18					26
		19					26
		22					22
		20				37	26
Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 8

LOG OF BORING NO. B-8

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION
0 – 2	SANDY LEAN CLAY (CL), yellowish red and brown
2 – 6	SILTY CLAY (CL-ML), yellowish red and brown
6 – 14	SANDY SILT (ML), loose to medium dense, yellowish red and brown
14 – 30	SILTY SAND (SM), loose to medium dense, reddish brown
30	Boring terminated at 30 feet

Approx. Depth, ft	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
1		12				69	7
3		23					3
5		25				97	4
7		21					5
9		21					8
11		26					13
13		25				70	4
15		21					4
19		27					16
24		21				41	24
29		19					21

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

ELEVATION, FEET | DEPTH, FEET | SYMBOL | SAMPLES

WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 8.0 FT. DURING DRILLING.

Plate No. 9

LOG OF BORING NO. B-9

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0	LEAN CLAY (CL), yellowish red and brown	112	10					
			24	31	21	10		
5	SILTY CLAY (CL-ML), yellowish red and reddish brown		22	24	20	4	94	
	-loose silt layer between 6' to 8'		21					
	SANDY SILT (ML), loose, yellowish red and reddish brown		23					2
10	SILTY SAND (SM), loose to medium dense, reddish brown		22				42	4
			22					7
15			24					18
	SANDY SILT (ML), medium dense, reddish brown		22				54	20
20								
	SILTY SAND (SM), medium dense, reddish brown		22					22
25								
			18				23	24
30	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF
- HAND PENETROMETER
- TORVANE
- UNCONFINED COMPRESSION
- UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 10

LOG OF BORING NO. **B-10**

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
SILTY CLAY (CL-ML), stiff, reddish brown with slickensided (0 to 6 ft)		13	25	20	5		
	85	19					
		24				97	3
SANDY SILT (ML), loose, yellowish red and brown (6 to 10 ft)		22					4
		21					6
SILTY SAND (SM), medium dense to dense, reddish brown (10 to 30 ft)		21				36	10
		23					30
		25					21
		25				31	23
		23					22
		22				14	

Boring terminated at 30 feet

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (scale 0.5, 1.0, 1.5, 2.0, 2.5)

WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 11

LOG OF BORING NO. B-11

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-21-10 COMPLETION DEPTH : 10.0 FT.

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (scale 0.5, 1.0, 1.5, 2.0, 2.5)

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot	UNDRAINED SHEAR STRENGTH, TSF
		SURFACE ELEVATION:								
	0	LEAN CLAY (CL), stiff, yellowish red and reddish brown	100	22	31	19	12			○ 1.0
		SILTY CLAY (CL-ML), very soft, reddish brown		16	27	21	6	98		○ 0.0
	5			26					2	
		SANDY SILT (ML), loose to medium dense, yellowish red and reddish brown		24					5	
				25				71	12	
	10	Boring terminated at 10 feet								

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 6.0 FT. DURING DRILLING.

Plate No. 12

LOG OF BORING 7296.GPJ QC_LABS.GDT 9/3/10

LOG OF BORING NO. **B-12**

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-23-10 COMPLETION DEPTH : 30.0 FT.

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
	SURFACE ELEVATION:							
0	LEAN CLAY (CL), stiff to soft, yellowish red and reddish brown with slickensided	100	22	45	18	27		
		101	21					
5	FAT CLAY (CH), firm, yellowish red and reddish brown with silt layer	86	32	77	25	52	99	
	SILTY SAND (SM), loose, reddish brown		30					3
			26				15	2
10			26					5
	-becomes medium dense between 12' to 30'		28					10
15			24				24	15
20			303					14
25			223					18
30			25				35	18
	Boring terminated at 30 feet							

ELEVATION, FEET · SYMBOL · SAMPLES

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

LOG OF BORING NO. B-13

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-28-10 COMPLETION DEPTH : 10.0 FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot	UNDRAINED SHEAR STRENGTH, TSF (○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL) 0.5 1.0 1.5 2.0 2.5
			SURFACE ELEVATION:									
	0		LEAN CLAY (CL), very stiff to firm, dark reddish brown with slickensided		100	24	43	18	25			
					103	20						
	5				93	27	33	18	15			
▽			-becomes very soft, yellowish red with silt layer between 6' to 10'			25						
						30				99		
	10		Boring terminated at 10 feet									
	15											
	20											
	25											
	30											

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

LOG OF BORING NO. B-14

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-28-10 COMPLETION DEPTH : 10.0 FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION:								
	0		FAT CLAY (CH), stiff, dark reddish brown with slickensided		94	25					
						18	71	21	50		
	5		LEAN CLAY (CL), stiff, yellowish red and reddish brown with slickensided			22					
			-with silt layer between 6' to 8'			26					
			SILT (ML), wet, reddish brown			33					
	10		Boring terminated at 10 feet								
	15										
	20										
	25										
	30										

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 15

LOG OF BORING 7296.GPJ QC_LABS.GDT 9/3/10

LOG OF BORING NO. B-15

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-28-10 COMPLETION DEPTH : 10.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0	FAT CLAY (CH), very stiff to stiff, dark reddish brown with slickensided	100	25					
		103	19	60	18	42		
4	LEAN CLAY (CL), stiff, yellowish red and reddish brown with silt layer		23					
6	SILT (ML), wet, loose, reddish brown		25				91	4
			27					6
10	Boring terminated at 10 feet							

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (scale 0.5, 1.0, 1.5, 2.0, 2.5)

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 16

LOG OF BORING NO. **B-16**

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-23-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0	FAT CLAY (CH) , stiff, reddish brown with slickensided							
		97	22	56	20	36		
		90	28					
	-becomes soft to stiff between 4' to 6'							
5		84	36					
6	LEAN CLAY (CL) , stiff, yellowish red and reddish brown							
			25	31	20	11	99	
	-with silt layer between 8' to 10'							
			29					
10	FAT CLAY (CH) , stiff, reddish brown with slickensided							
			27	67	20	47	98	
12	SILTY SAND (SM) , loose to medium dense, reddish brown							
			26					5
15			27	NP	NP	NP	20	8
			23					20
20								
			22					18
25	POORLY GRADED SAND WITH SILT (SP-SM) , medium dense, reddish brown							
			24				10	21
30	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 17

LOG OF BORING 7296.GPJ QC_LABS.GDT 9/3/10

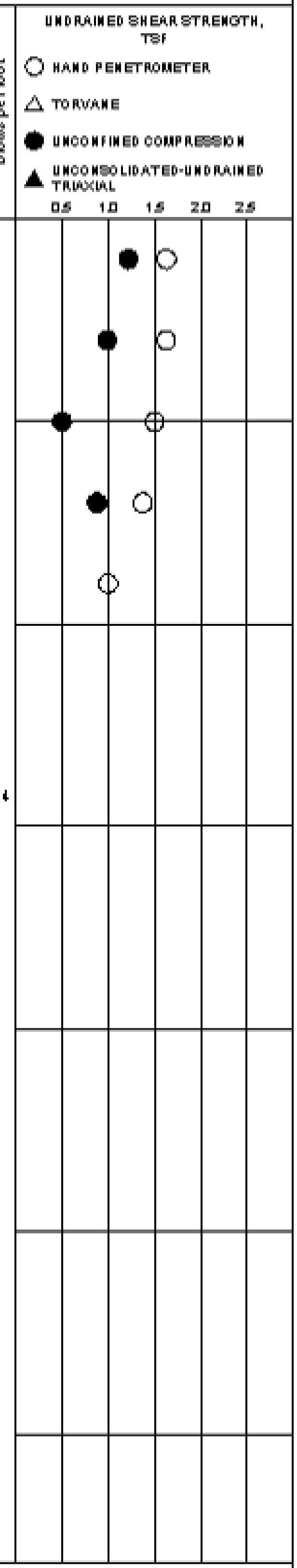
LOG OF BORING NO. B-17

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-23-10 COMPLETION DEPTH : 10.0 FT.

SURFACE ELEVATION:

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
	0		FAT CLAY (CH), stiff to firm, reddish brown with slickensided		89	31					
					88	30	89	22	67		
	5				80	39					
			LEAN CLAY (CL), stiff, yellowish red and reddish brown with slickensided		99	26				99	
			-with silt layer between 8' to 10'			23					
	10										
			SILTY SAND (SM), loose, reddish brown			32					4
	15		Boring terminated at 15 feet								
	20										
	25										
	30										



WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 18

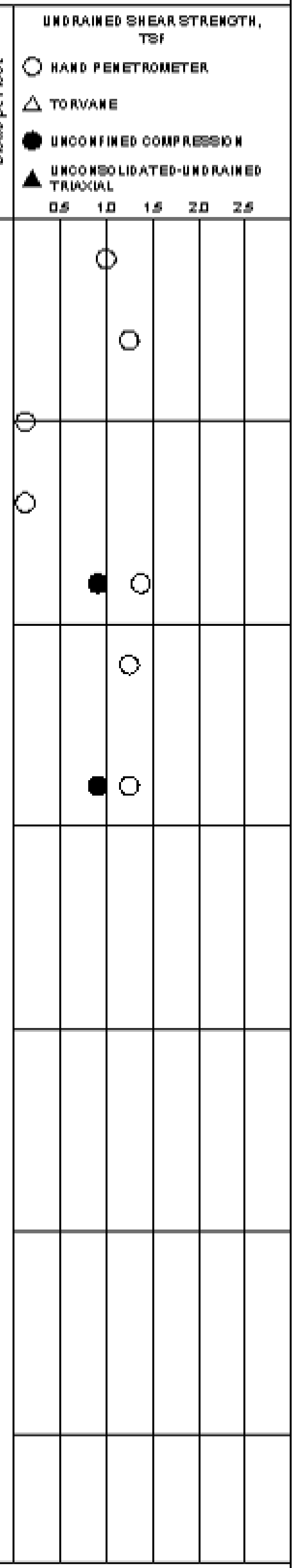
LOG OF BORING NO. B-18

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-27-10 COMPLETION DEPTH : 16.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
	0	SURFACE ELEVATION:							
		LEAN CLAY (CL), stiff, yellowish red and reddish brown		26	42	18	24		
				13					
	5	SANDY SILT (ML), reddish brown		26					
		-becomes wet between 6' to 8'		27					
		FAT CLAY (CH), stiff to firm, reddish brown with slickensided	94	29	66	20	46		
	10			26					
			92	32					
	15	Boring terminated at 15 feet							
	20								
	25								
	30								

UNDRAINED SHEAR STRENGTH, TSF



WATER OBSERVATIONS:

▽: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 19

LOG OF BORING NO. B-19

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-27-10 COMPLETION DEPTH : 16.0 FT.

SURFACE ELEVATION:

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot	UNDRAINED SHEAR STRENGTH, TSF
	0		FAT CLAY (CH) , stiff to firm, reddish brown with slickensided		84	35	91	23	68			
					87	31						
	5				96	19						
			LEAN CLAY (CL) , very stiff to firm, yellowish red and reddish brown			19	48	16	32			
						23						
	10					28						
			CLAY WITH SILT (CL-ML) , stiff to soft, yellowish red and reddish brown with silt layer		91	31						
	15		Boring terminated at 15 feet									
	20											
	25											
	30											

Undrained shear strength legend: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL. Scale: 0.5, 1.0, 1.5, 2.0, 2.5

WATER OBSERVATIONS:
∇ : FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

LOG OF BORING NO. B-20

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-27-10 COMPLETION DEPTH : 16.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0	FAT CLAY (CH) , stiff to firm, dark reddish brown with slickensided	90	30	70	19	51		
			34					
5		82	37					
		76	43	81	22	59		
	CLAY WITH SILT (CL-ML) , very soft, yellowish red and reddish brown		22					
10			21	24	19	5	80	
	SILTY SAND (SM) , loose, reddish brown		24					2
15	Boring terminated at 15 feet							

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
∇ : FREE WATER ENCOUNTERED AT 12.0 FT. DURING DRILLING.

LOG OF BORING NO. B-21

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-27-10 COMPLETION DEPTH : 30.0 FT.

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
	SURFACE ELEVATION:							
0	FAT CLAY (CH), stiff to firm, reddish brown with slickensided	92	29	66	20	46		
		86	32					
5	LEAN CLAY (CL), stiff, yellowish red and reddish brown		22	35	17	18		
			30					
	-becomes very soft with silt layers between 8' to 10'		23	40	16	24	99	
10	SILTY SAND (SM), loose, reddish brown and yellowish red		25					4
15			23					3
20	-becomes medium dense between 18' to 30'		24					17
25			23	NP	NP	NP	19	27
30			23					31
	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (scale 0.5, 1.0, 1.5, 2.0, 2.5)

WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 10.0 FT. DURING DRILLING.

Plate No. 22

LOG OF BORING NO. B-22

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-28-10 COMPLETION DEPTH : 10.0 FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot	UNDRAINED SHEAR STRENGTH, TSF
			SURFACE ELEVATION:									
	0		LEAN CLAY (CL), stiff, reddish brown with slickensided			19	43	15	28			Hand penetrometer ≈ 1.5
						35						Hand penetrometer ≈ 1.0
	5		-becomes firm, yellowish red with silt seams between 4' to 10'		81	36						Unconfined compression ≈ 0.4; Hand penetrometer ≈ 1.1
						27						Hand penetrometer ≈ 0.75
						33						Hand penetrometer ≈ 1.0
	10		Boring terminated at 10 feet									

Legend: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL

Shear strength scale: 0.5, 1.0, 1.5, 2.0, 2.5

Depth scale: 0, 5, 10, 15, 20, 25, 30

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

LOG OF BORING NO. B-23

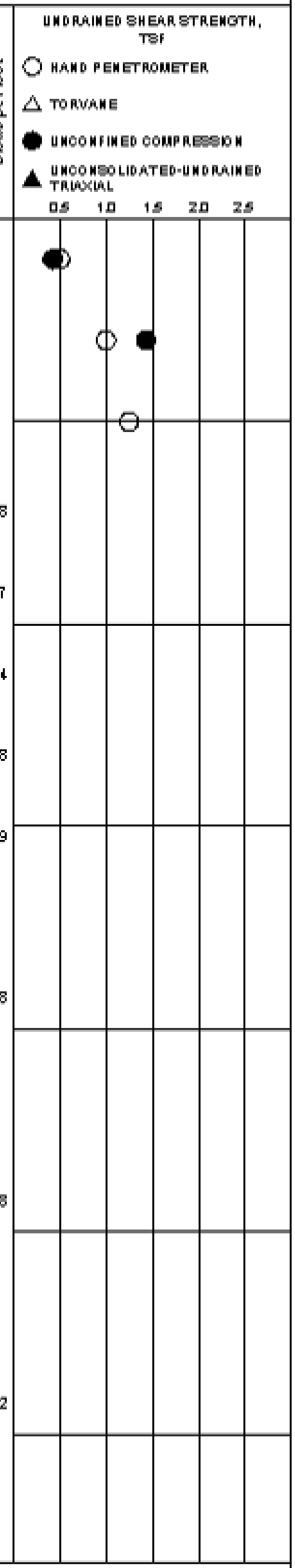
QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-26-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
	0	FAT CLAY (CH) , firm to stiff, reddish brown with slickensided	84	26	78	22	56		
			91	31					
	5		97	19					
		LEAN CLAY (CL) , yellowish red and reddish brown -with silt layers between 6' to 8'		25	28	19	9	91	8
				38					7
	10	SANDY SILT (ML) , loose, reddish brown		30					4
				30				66	8
	15	SILTY SAND (SM) , loose to medium dense, reddish brown							9
				23					18
	20	POORLY GRADED SAND WITH SILT (SP-SM) , medium dense, reddish brown							
	25			21				7	18
				23					22
	30	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF



WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

Plate No. 24

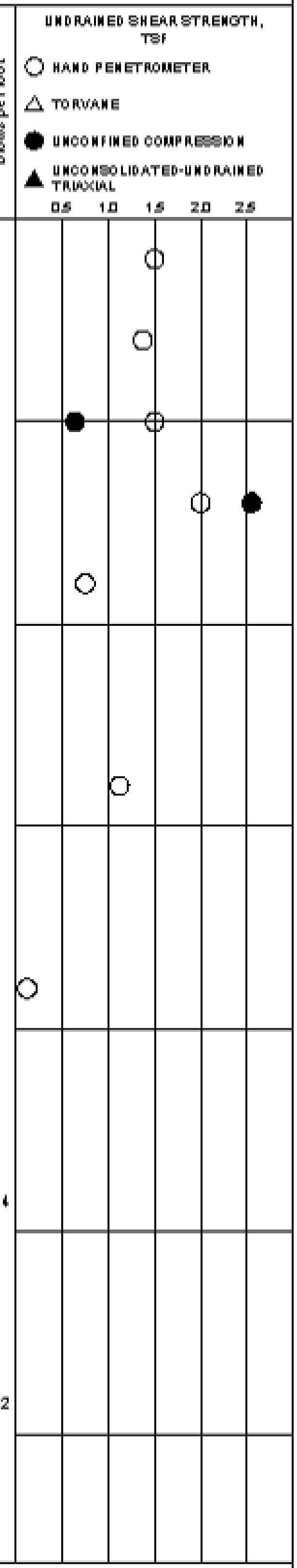
LOG OF BORING NO. **B-24**

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-27-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0	FAT CLAY (CH) , stiff to firm, yellowish red and dark reddish brown with blocky structures and silt fissures		22	74	23	51		
			34					
5		87	35					
	-becomes very stiff, reddish brown with silt fissures between 6' to 8'	104	19	54	19	35		
	LEAN CLAY (CL) , firm, yellowish red and reddish brown with silt layers between 8' to 10'		19	38	17	21	99	
10								
	-becomes stiff reddish brown between 13' to 15'		28					
15	SANDY SILT (ML) , wet, reddish brown							
			26					
20								
	SILTY SAND (SM) , loose, reddish brown		21				22	4
25								
	-with clay pockets between 28' to 30'		25					2
30	Boring terminated at 30 feet							



WATER OBSERVATIONS:
▽: FREE WATER ENCOUNTERED AT 10.0 FT. DURING DRILLING.

LOG OF BORING NO. B-25

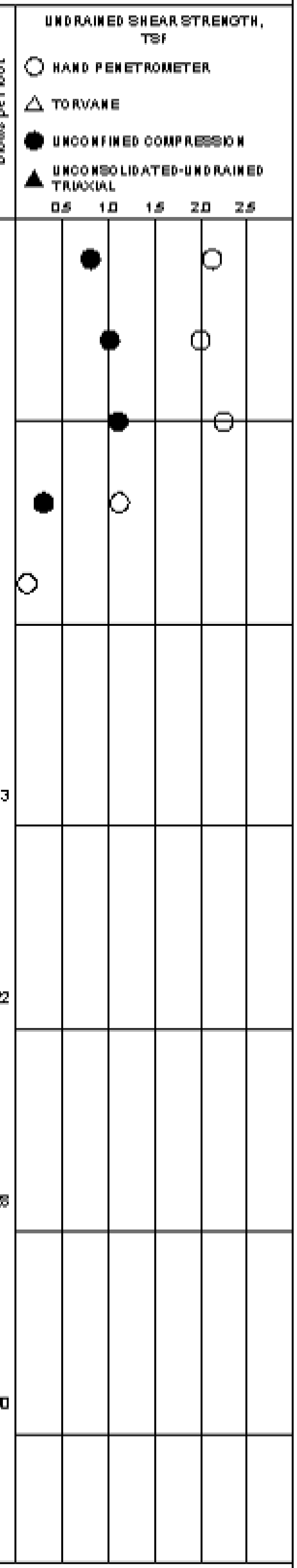
QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-27-10 COMPLETION DEPTH : 30.0 FT.

SURFACE ELEVATION:

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0	FAT CLAY (CH) , firm to stiff, reddish brown with slickensided	97	27	87	26	61		
		85	25					
4	LEAN CLAY (CL) , very stiff to soft, yellowish red and reddish brown							
5		110	15	37	12	25		
		90	26					
	-with silt layer between 8' to 10'		27	29	19	10		
10	SANDY SILT (ML) , medium dense, reddish brown		24				76	
			23					13
15	SILTY SAND (SM) , medium dense, reddish brown							
			26					22
20								
			23					28
25	POORLY GRADED SAND WITH SILT (SP-SM) , dense, reddish brown							
			25					30
30	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF



WATER OBSERVATIONS:
FREE WATER ENCOUNTERED AT 10.0 FT. DURING DRILLING.

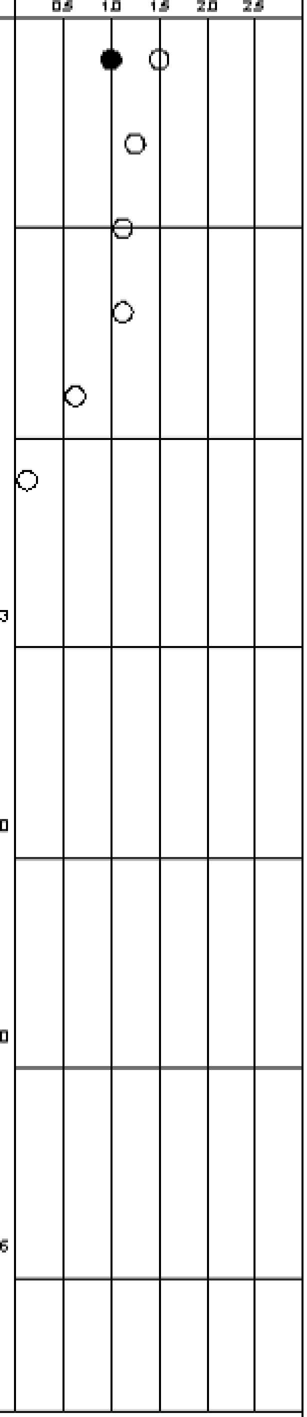
LOG OF BORING NO. B-26

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-27-10 COMPLETION DEPTH : 30.0 FT.

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
	SURFACE ELEVATION:							
0	FAT CLAY (CH), stiff to firm, reddish brown with slickensided	91	26	66	23	43		
			34					
5			37					
			34					
	-with silt layers between 8' to 10'		29	77	22	55	99	
10	SANDY SILT (ML), medium dense, reddish brown		23					
			27					13
15	SILTY SAND (SM), medium dense, reddish brown							
			25				20	20
20								
			26					20
25								
			26				19	26
30	Boring terminated at 30 feet							

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL



WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 10.0 FT. DURING DRILLING.

LOG OF BORING NO. B-27

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-28-10   COMPLETION DEPTH : 10.0 FT.

ELEVATION, FEET	DEPTH, FEET	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot	UNDRAINED SHEAR STRENGTH, TSF (0.5 1.0 1.5 2.0 2.5)
			SURFACE ELEVATION:									
	0	▨	FAT CLAY (CH) , firm to stiff, dark reddish brown with blocky structures	■		20	66	23	43			○
		▨		■	84	38						● ○
	5	▨		■		34						○
		▨		■	93	29	85	21	64			● ○
		▨		■		28						○
	10		Boring terminated at 10 feet									
	15											
	20											
	25											
	30											

Legend: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

Plate No. 28

LOG OF BORING NO. B-28

QC LABORATORIES, INC.
Geotechnical & Materials Engineers

PROJECT: Sugar Land Baseball Park
LOCATION: Near Hwy 6 & Hwy 90 Alt, Sugar Land, TX
PROJECT NO.: 10G7296
DATE: 8-28-10 COMPLETION DEPTH : 16.0 FT.

DEPTH, FEET	DESCRIPTION	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
0	SURFACE ELEVATION:							
	LEAN CLAY (CL), stiff to firm, reddish brown with slickensided	102	17					
			23	47	17	30		
5	-becomes very soft with silt layer between 5' to 6'		26	28	19	9	99	
	SANDY LEAN CLAY (CL), wet, very soft, brownish yellow with silt layer		23					4
			22				58	6
10	SANDY SILT (ML), loose, yellowish red							
			25					7
15	Boring terminated at 15 feet							

UNDRAINED SHEAR STRENGTH, TSF: ○ HAND PENETROMETER; △ TORVANE; ● UNCONFINED COMPRESSION; ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL (0.5 1.0 1.5 2.0 2.5)

WATER OBSERVATIONS:
∇: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

Plate No. 29

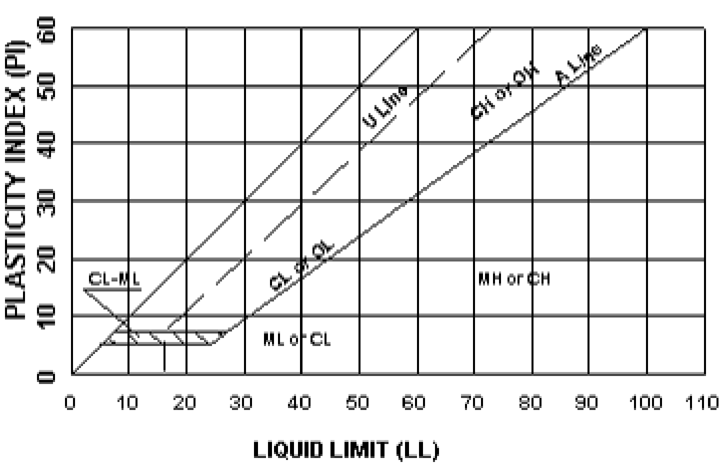
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation D-2487

MAJOR DIVISIONS				GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (Less than 50% of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 6% passes No. 200 sieve)		GW	WELL-GRADED GRAVEL, WELL-GRADED GRAVEL WITH SAND
				GP	POORLY-GRADED GRAVEL, POORLY-GRADED GRAVEL WITH SAND
		GRAVELS WITH FINES More than 12% passes No. 200 sieve	Limits plot below "A" line & hatched zone on plasticity chart	GM	SILTY GRAVEL, SILTY GRAVEL WITH SAND
			Limits plot above "A" line & hatched zone on plasticity chart	GC	CLAYEY GRAVEL, CLAYEY GRAVEL WITH SAND
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 6% passes No. 200 sieve)		SW	WELL-GRADED SAND, WELL-GRADED SAND WITH GRAVEL
				SP	POORLY-GRADED SAND, POORLY-GRADED SAND WITH GRAVEL
		SANDS WITH FINES More than 12% passes No. 200 sieve	Limits plot below "A" line & hatched zone on plasticity chart	SM	SILTY SAND, SILTY SAND WITH GRAVEL
			Limits plot above "A" line & hatched zone on plasticity chart	SC	CLAYEY SAND, CLAYEY SAND WITH GRAVEL
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)		SILTS AND CLAYS (Liquid Limit Less than 50%)		ML	SILT, SILT WITH SAND, SILT WITH GRAVEL SANDY SILT, GRAVELLY SILT
				CL	LEAN CLAY, LEAN CLAY WITH SAND, LEAN CLAY WITH GRAVEL, SANDY LEAN CLAY, GRAVELLY LEAN CLAY
				OL	ORGANIC CLAY, ORGANIC CLAY WITH SAND, SANDY ORGANIC CLAY, ORGANIC SILT, SANDY ORGANIC SILT
		SILTS AND CLAYS (Liquid Limit 50% or More)		MH	ELASTIC SILT, ELASTIC SILT WITH SAND, SANDY ELASTIC SILT, GRAVELLY ELASTIC SILT
				CH	FAT CLAY, FAT CLAY WITH SAND, FAT CLAY WITH GRAVEL, SANDY FAT CLAY, GRAVELLY FAT CLAY
				OH	ORGANIC CLAY, ORGANIC CLAY WITH SAND, SANDY ORGANIC CLAY ORGANIC SILT, SANDY ORGANIC SILT

NOTE: Coarse soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone of the plasticity chart are to have dual symbols.

PLASTICITY CHART



Equation of A-Line: Horizontal at PI=4 to LL=25.5, PI=0.73(LL-20)

Equation of U-Line: Vertical at LL=16 to PI=7, then PI=0.9(LL-8)

DEGREE OF PLASTICITY OF COHESIVE SOILS

DEGREE OF PLASTICITY	PLASTICITY INDEX
None	0 - 4
Slight	5 - 10
Medium	11 - 20
High	21 - 40
Very High	>40

SOIL SYMBOLS

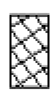
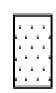
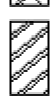
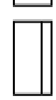
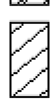
	Fill		SAND
	FAT CLAY (CH)		SILT
	LEAN CLAY (CL)		

PLATE NO. 30

ASSUMPTIONS FOR PAVEMENT ANALYSIS

1.0 Traffic Conditions - (National Crushed Stone Assoc.)

1.01 Parking Lots

Light traffic - Few vehicles heavier than cars.
No regular use by trucks.

Daily EAL = 6 or less

1.02 Medium Duty Access Lanes

Medium-Light traffic - Maximum of 1,000 vehicles per day, including not more than 10 percent two axle loaded trucks or larger vehicles carrying light loads or empty.

Daily EAL = 6 to 20

1.03 Heavy Duty Access Drives

Heavy Duty traffic - Maximum of 3,000 vehicles per day, including not more than 10 percent two axle trucks or 1 percent heavy trucks with three or more axles.

Daily EAL = 21 to 75

2.0 Flexible Base Pavement

2.01 Saturated CBR of natural sandy clay subgrade: 3

2.02 CBR of imported sandy clay subgrade: 6

3.0 Rigid Pavement

3.01 Modulus of subgrade reaction: 100 pci
(imported sandy clay subgrade)

3.02 Modulus of rupture: 500 psi at 7 days
(concrete)

PAVEMENT MATERIAL RECOMMENDATIONS

1.0 Limestone Base - Base material shall be composed of crushed limestone meeting the requirements of grade 1 in the Texas Department of transportation (TXDOT) 2004 Standard Specifications Item 247. The limestone shall be compacted to a minimum of 95 percent of the maximum density as determined by the Standard moisture/density relation (ASTM D698).

2.0 Hot Mix Asphaltic Concrete Surface Course (Class "A") - The asphaltic surface course should be plant mixed, hot laid Type "D": (Fine Graded Surface Course) and meet the requirements specified in TXDOT Item 340.

3.0 Asphalt Stabilized Base - Plant Mix - The asphaltic base should be plant mixed, hot laid and meet the requirements specified in the TXDOT 2004 Standard Specifications Item 340 (TYPE "A" Coarse Graded Base Course). It should also meet the following requirements as determined by the TXDOT Test Methods:

Hveem Stability	35 min.
Voids Filled	70-80
Total Voids	5-9

4.0 Concrete - The materials and properties of concrete shall meet the applicable requirements in the ACI Manual of Concrete Practice. The concrete shall have a minimum modulus of rupture of 500 psi at 7 days. It is our experience that concrete with a compressive strength of 3,000 psi will meet these criteria. The mixture shall contain 3 to 5 percent entrained air.

Client: City of Sugarland
Project Name: Proposed Baseball Stadium
Project Number: 10G7296
Date: September 7, 2010

Boring Coordinates

Boring No.	Total Depth, Ft.	Coordinates	
B-1	30	N 29°37' 25.26"	W 95°38' 47.5"
B-2	30	N 29°37' 23.68"	W 95°38' 51.41"
B-3	15	N 29°37' 25.15"	W 95°38' 50.20"
B-4	30	N 29°37' 24.46"	W 95°38' 51.46"
B-5	30	N 29°37' 25.29"	W 95°38' 51.40"
B-6	10	N 29°37' 26.43"	W 95°38' 50.84"
B-7	30	N 29°37' 25.60"	W 95°38' 50.67"
B-8	30	N 29°37' 25.87"	W 95°38' 49.78"
B-9	30	N 29°37' 26.66"	W 95°38' 48.95"
B-10	30	N 29°37' 25.78"	W 95°38' 48.77"
B-11	10	N 29°37' 27.15"	W 95°38' 47.91"
B-12	30	N 29°37' 22.65"	W 95°38' 51.04"
B-13	10	N 29°37' 22.01"	W 95°38' 52.36"
B-14	10	N 29°37' 19.26"	W 95°38' 51.71"
B-15	10	N 29°37' 17.19"	W 95°38' 49.17"
B-16	30	N 29°37' 21.76"	W 95°38' 50.53"
B-17	15	N 29°37' 22.78"	W 95°38' 49.52"
B-18	15	N 29°37' 23.57"	W 95°38' 48.96"
B-19	15	N 29°37' 22.49"	W 95°38' 48.31"
B-20	15	N 29°37' 23.19"	W 95°38' 47.68"
B-21	30	N 29°37' 23.70"	W 95°38' 47.06"
B-22	10	N 29°37' 25.16"	W 95°38' 45.07"
B-23	30	N 29°37' 21.14"	W 95°38' 49.98"
B-24	30	N 29°37' 20.75"	W 95°38' 48.51"
B-25	30	N 29°37' 22.00"	W 95°38' 46.81"
B-26	30	N 29°37' 23.00"	W 95°38' 46.06"
B-27	10	N 29°37' 18.56"	W 95°38' 47.10"
B-28	15	N 29°37' 24.46"	W 95°38' 48.05"